Implications of Climate Change on New England Extreme Weather Events

Barry D. Keim
New Hampshire State Climatologist
Department of Geography, University of New Hampshire*

In recent years, it appears that extreme events have been ubiquitous in the United States, particularly in the Northeast. At the national level, we have experienced:

- flooding in Washington and Oregon (December, 1996-January, 1997)
- The Ohio River Valley Flood (Spring, 1997)
- Northern Great Plains Flooding (Spring, 1997)
- Over 30 inches of rainfall in Alabama resulting from Hurricane Danny (July, 1997)

And in the Northeast:

- Region-wide blizzard with storm snowfall totals in excess of 30 inches (January, 1996)
- Coastal New England Rainstorm producing over 19 inches of rainfall (October, 1996)
- Warmest single-day February temperature record in Seacoast of New Hampshire (1997)
- Boston's new 24-hour snowfall record broken (April, 1997).

Other evidence of increasing extremes is provided by Changnon et al., (1997) in the form of increasing trends in weather-related insurance claims and by Karl et al., (1996) who show that the proportion of annual rainfall contributed by 1-day extremes appears to have increased in the United States over the past century. Regarding the insurance claims, one difficulty in assessing whether extremes are temporally increasing is that population is also increasing. In addition, society is developing land in vulnerable locations like the coastal zone (which is susceptible to hurricanes), and floodplains (which are vulnerable to river-basin floods) leaving more people impacted by these events when they occur.

Predicting future extreme events in a changing climate has proven to be a difficult task. Most of what is known about future climates is derived from general circulation models (GCMs). The various GCMs (e.g., Goddard Institute for Space Studies, Geophysical Fluid Dynamics Laboratory, National Center for Atmospheric Research, Oregon State University, United Kingdom Meteorological Office) generally agree that global temperature and precipitation should increase as concentrations of atmospheric greenhouse gases increase, but regional impacts remain unclear. Furthermore, most extreme events (e.g., intense precipitation events, tornadoes, hurricanes, high winds, etc.) are too small in scale for GCM recognition and therefore the GCMs are of limited value in predicting extremes.

Though the GCMS are of little assistance in directly projecting future extremes, global warming has implications on future events, although with mixed possibilities. First, global warming would likely translate into warmer global sea surface temperatures (SSTs). It was found that warmer SSTs are strongly correlated with increases in tropical storm frequencies, at least in the north Atlantic Basin (Wendland, 1977), which impacts storm frequencies in the eastern United States. Similarly, Emanual (1987) reports that hurricane intensity is likely to increase under warmer conditions globally. However, time series of annual hurricane frequencies over the past 100+ years do not show any trend toward increasing frequencies. Furthermore, hurricane intensities do not appear to be increasing either as evidenced by the most powerful storms to strike the eastern United States over the past century. These hurricanes occurred in the following years in decending order; 1935, 1969, 1992, 1919, 1928, 1960, 1900, 1909, 1915, and 1961. A second implication of global warming is based on the spatial dimensions of the warming. Most GCMs are predicting that higher latitudes will warm to a much larger extent than lower latitudes. As a result, there would be a reduction in the temperature gradient between the tropics and poles. It is this gradient, however, that drives most of the severe weather in the mid-latitudes and a gradient reduction may lead to a reduction in atmospheric mixing, thereby reducing severe weather.

Predicting extremes in New England and New York is particularly difficult because of the region's geographic location. It is positioned roughly halfway between the equator and the North Pole and is exposed to both cold and dry airstreams from the north and warm and moist

* See Appendix V for authors' affiliations and addresses.

airstreams from the south. The interaction between these opposing airmasses often leads to turbulent weather across the region. Also, because of the propensity of storm tracks to move across this region, the jet stream is frequently positioned overhead. The complicating factor here is that very small shifts in storm tracks and jet stream location lead to highly differing weather conditions region-wide. Currently, GCMs do not have the capability to predict how these storm tracks, nor jet stream locations, may shift in a warmer climate. Regarding extremes of the past in this region, cursory examination suggests slightly warmer extreme cold conditions in southern New Hampshire, and perhaps an increase in the frequency of extreme precipitation events in southern New England. Both of these are in general agreement with increases in annual temperature and precipitation found across the region (Karl et al., 1994a; Karl et al 1994b). In addition, Davis and Dolan (1993) report that over the past 50 years, the total number of East Coast nor'easters appears to be decreasing, but that the most powerful ones seem to be increasing in frequency.

In conclusion, little is really know about the response of extreme events in a changing climate. There is limited evidence that extremes have been on the rise, but this is somewhat muddled by increasing population and changing zoning practices. Furthermore, climate models are not yet sensitive enough to yield reliable information at a scale associated with most extreme events. At this point, we clearly need more time and research to assess the true impacts of a changing climate on extreme weather phenomena.

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